Preface

Amorphous semiconductors find applications in a variety of areas such as Xerography, infrared optics, solar cells, etc The present thesis deals with the electrical switching behaviour of amorphous chalcogenide semiconductors with emphasis on different switching device applications

The first chapter of the thesis discusses the fundamental aspects of the amorphous semiconducting glasses It also gives an overview of the phenomenon of electrical switching exhibited by chalcogenide glasses The advantages and applications of amorphous semiconductors are described

The second chapter details the instrumentation used for studying the switching characteristics of samples in both bulk and thin film form The flash evaporation unit and quartz crystal monitor designed and developed for evaporating thin/thick film switching devices, are discussed

The third chapter discusses about the switching behaviour of bulk, amorphous Al-Te chalcogenide semiconductors prepared by melt quenching method The samples are characterized by X-ray diffraction technique and Differential Scanning Calorimetry All the $Al_xTe_{100\,x}$ ($15 < x < 25$) glass compositions are found to exhibit Current Controlled Negative Resistance (CCNR) with memory The threshold fields (E_t) are observed to increase linearly with increase in the atomic percentage of Al up-to x=23, which is explained by the Formal valence shell model The sharp increase in E_t above x=23 is understood on the basis of rigidity percolation in network glasses A model has been proposed using the configurational free energy diagram to explain the observed decrease in E_t with increasing temperature

The fourth chapter describes the easily reversible memory switching in Ge-As-Te glasses The memory state in these samples are found to be easily revertible even by transients produced in the circuitry used (20mA/300ns current pulse) The setting and resetting processes are carried out for 50 cycles and the characteristics are found to be stable Further, a regular resetting pulse of 10mA and 30μs is found to reset these samples for a stable 1000 cycles operation These results clearly indicate that Ge-As-Te samples are ideal for Read Mostly Memory (RMM) applications Further, a clear relationship has been established between the glass forming ability and easy re-settability of memory switching chalcogenide glasses which will be helpful for future design of glasses for RMM applications

Power control applications require devices that would exhibit threshold behaviour The fifth chapter brings out a new guideline proposed to design chalcogenide glasses which exhibit threshold switching Based on this guideline a new Al-Ge-As-Te glassy system has been formed The samples are found to exhibit the expected threshold characteristics These devices have a switching time of ~30ns and a lifetime greater than 10^5 cycles Studies on thickness and temperature dependence of threshold voltage of these glasses have been undertaken, to understand the mechanism of switching

The sixth chapter reports the study on memory switching in Ge-Sb-Te thin film devices (3000 A° thick), which establishes the feasibility of developing practical thin film switching devices The scope for future work is also discussed

In the present thesis, a minimum of three switching experiments have been performed on each sample and the switching voltages reported are the average of the results obtained The percentage of error involved in the switching voltages obtained is less than $\pm$2 % Both field (E) and voltage (V) are used, depending on the context, for representing the electrical switching characteristics Also, the terms threshold voltage and switching voltage are used synonymously The general practice followed to treat the Current Controlled Negative Resistance (CCNR) behaviour and electrical switching in chalcogenides as synonymous, has been adopted

The references are numbered as they occur in the text and are listed at the end of each chapter